(54) FORMATION OF ELECTRODE OF SEMICONDUCTOR DEVICE
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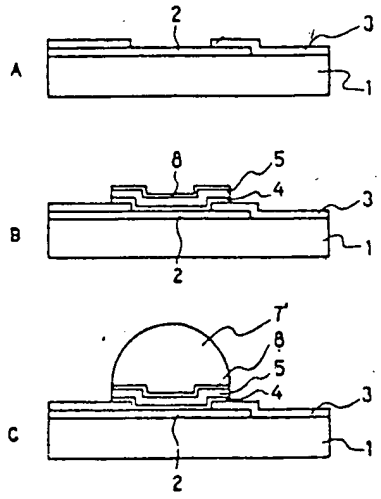
PURPOSE: To realize the formation of semi-spherical solder electrode having less dispersion of height by forming a base metal layer of which uppermost layer deposited on the opening of protection film is composed of a metal to be wet by the solder is formed in such a manner as having the specified diameter and dipping it into the melted solder.

CONSTITUTION: A surface protection film 3 which is not wet by the solder is formed on the main surface of silicon wafer providing a silicon substrate 1 and an aluminum wiring 2 and a contact hole is opened at the electrode forming region. The base metals 4, 5, 8 are formed in the sequence on the contact hole and the three-layer of base metal is etched in such a manner that it is left in the form of a circle larger than the diameter of contact hole. In this case, as the metal film 8 at the upper most layer, nickel which can be easily wet by solder and prevents diffusion of tin which is the element of solder 7 to the intermediate metal layer 5 is used. Thereafter, flux is applied to the silicon wafer, the entire part is dipped into the fused solder in the tank and is lifted up after 2~3sec. Thereby, a semispherical solder electrode 7 is formed at the uppermost layer 8 of the base metal.



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⑤④半導体装置の電極形成方法

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明 細 書

1. 発明の名称　半導体装置の電極形成方法

2. 特許請求の範囲

1) 素子機能と配線金属層とを備え、表面に保護膜を設けた半導体基板の前記配線金属上の電極を形成すべき個所に、前記保護膜を開口し、該開口部上に被着され最上層がはんだにぬれる金属からなる下地金属層を所定の径を持つように形成し、しかる後前記下地金属表面を溶融はんだ中に浸漬して突起電極を設けることを特徴とする半導体装置の電極形成方法。

2) 特許請求の範囲第1項記載の方法において、下地金属の径により、突起電極の高さを制御することを特徴とする半導体装置の電極形成方法。

3. 発明の詳細な説明

この発明はフェースダウンボンディング方式を採用する半導体素子の突起電極形成方法に関する。この種の突起電極としては、ボンディング時の自己位置決めが可能なことや、電極の高さのバラツキが少ないこと、ボンディング強度が充分に確保できることなどのほかに、上記突起電極の形成が容易に行なえることが望まれる。

この種のはんだ突起電極形成方法を工程順にその一例を第1図A～Dに示す。まず素子機能を作り込み、図示してない表面保護膜を被覆したシリコン基板1とアルミ配線2を備えたシリコンウエハの主表面に窒化シリコン膜などの表面保護膜3を形成し、電極形成部の穴開けを行なう(A)。つぎに、下地金属4，5を順次シリコンウエハ表面に形成するとともに、一層目の半田にぬれない下地金属4以外の下地金属5は、コンタクトホール上にコンタクトホールと同じ大きさまたはそれよりも大きな円状に残るように他の部分をエッチング除去する(B)。この際下地金属4はその後の電気めっき工程において、複数の電極部が等電位となるような役目を持たせるためにシリコンウエハ全面に被着したままにしておく。つぎに下地金属4，5のコンタクトホール部以外の部分をレジスト6でコーディングして(C)、露出している下地金属5上に電気めっき法によりはんだ7を形成する(D)。

たシリコン基板1とアルミ配線2を備えたシリコンウエハの主表面に酸化シリコン膜などのはんだにぬれない表面保護膜3を形成し、電極形成部にコンタクトホールの穴開けを行なう(A)。つぎに下地金属4，5，8をこの順に第1図に示したと同じ手法でコンタクトホール上に形成しこの三層の下地金属をコンタクトホールの径よりも大きな円状で残すようにエッチング加工する(B)。この場合、一層目の下地金属4は配線材料であるアルミや、図示してない表面保護膜に対して接着強度の強いクロム（C_r）やチタン（T_i）などを用い、最上層の金属膜8としては、はんだに容易にぬれ、かつ、中間金属層5へのはんだ7の成分である錫（Sn）の拡散を防止できるニッケル（Ni）などを用いる。中間金属層5は、一層目下地金属4と最上層下地金属8との電気的接触が良好で、これらの接続強度が大となるように銅（Cu）などを用いるのがよい。ついで、上記シリコンウエハにフラックスを塗布し、このシリコンウエハ全体を溶融半田槽に浸漬し、2～3秒で引上げると、第2図Cに示すように、下地金属の最上層8に、半球状の半田電極7′が形成される。この方法により下地金属の直径が160 μmの場合、半田突起電極の高さは40 μm程度で、高さのばらつきは±3 μm以下におさえられる。

この発明によれば、下地金属の径を決定するだけで、その上に任意の高さにしかも高さのばらつきが少ない半球状のはんだ電極が形成できるばかりでなく、このはんだの突起電極形成はメッキや蒸着などの面倒な工程を経ることなく溶融はんだ槽へのウエハの浸漬のみで完了するので大巾な工数削減になると同時に、突起電極の形成に要する時間は数秒程度であるから極めて簡便に実施でき著しく作業効率が向上するなど大きな効果をもたらすものである。

この発明は、今まで説明した半球状の突起電極ばかりでなく、下地金属の形状寸法を任意に規定し、所望の形状の突起電極を得る場合にも応用できることは勿論である。

4. 図面の簡単な説明

レジスト6を除去した後、熱処理によりはんだを溶融し、半球状のはんだ電極7′を形成する(D)。最後に下地金属4をはんだ球7′をマスクとしてエッチング除去する(F)。なお、上記方法において、はんだの形成は蒸着法を用いることも知られている。

しかしながら、上記の方法には、はんだ膜厚を数十ミクロン形成する場合に、電気めっき法、蒸着法のいずれの場合も、処理工数が大でコストアップにつながること、膜厚の制御が難しいこと、電気めっきの場合、はんだ球形成後に一層目の下地金属のエッチング除去工程があり、半田溶出などの電気化学的に発生する問題が内在するなどいくつかの欠点がある。

この発明は、上述の欠点を除去し、簡便な半田突起電極の形成方法を提供することを目的とする。

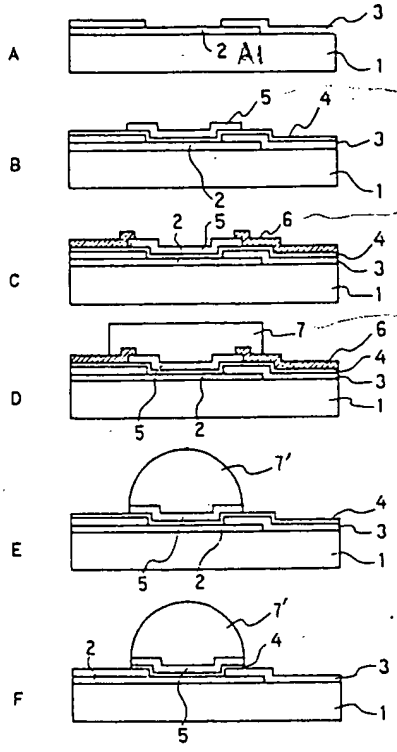
以下本発明を実施例に基き説明する。

第2図A～Cは本発明の方法によるはんだ突起電極の製造工程の概要を示したものであり、第1図と同一符号は同一名称を表わしている。素子領域を作り込み、図示してない表面保護膜を被覆し

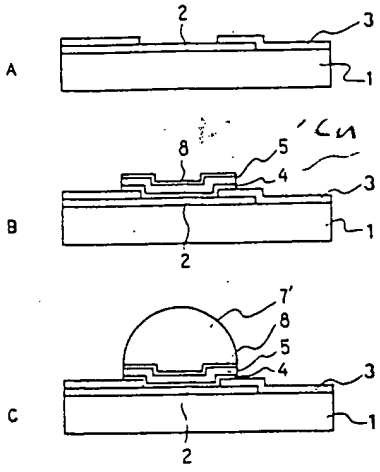
第1図は従来のはんだ突起電極形成方法を示す工程図、第2図は同じく本発明による工程図である。

1…シリコン基板、2…アルミ配線、3…酸化シリコン膜、4，5，8…下地金属、7…はんだ、7′…半球状はんだ電極。

代理人弁理士 山口 巖



第 1 図



第 2 図

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(54) Method for Formation of Electrode of Semiconductor Device

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Specification

1. Title of Invention

Method of Formation for Electrode of Semiconductor Device

2. Claim

1) The present invention is a method of formation for the electrode of a semiconductor device and has the following characteristics: (a) it is equipped with an element function and a wired metal layer; (b) an opening is made on a protective film at a location where an electrode is formed on the above-mentioned wired metal on a semiconductor substrate which is equipped with a protective film on the back; (c) it is covered on the aforementioned opening part and it forms a base metal layer with a specific diameter which is made up of a metal whose uppermost layer is wetted in the solder; (d) after this, however, the above-mentioned base metal surface is dipped into the melted solder and has a protruding electrode.

2) The present invention is a method for formation of an electrode of a semiconductor device which has the following characteristics. In the method described in paragraph 1 of the Claim, the height of the protruding electrode is controlled by the diameter of the base metal.

3. Detailed Description of Invention

The present invention refers to a method for formation of a protruding electrode with a semiconductor element which uses the face down bonding method. In this type of protruding electrode, [the electrode] can position itself during bonding, there is little dispersion [or deviation]

in the height of the electrode, the bonding strength can be thoroughly guaranteed and the above-mentioned protruding electrode can be easily formed.

Figure 1 A through 1 D illustrates an example of the sequence of soldering operations involved in formation of the protruding electrode. First, the element function is built in, a surface protection film 3 which is made of a silicon nitride film is formed on the main surface of a silicon wafer which is equipped with (1) a silicon substrate 1 which covers the surface protective film (not shown) and (2) aluminum wiring 2. Then, an opening is made on the electrode formation part (A). Next, the base metals 4, 5 are formed one after the other on the surface of the silicon wafer and the base metal 5 (exclusive of base metal 4 which is not wetted on the soldering of the first layer) is removed by etching another part so that a circle is left which is as large as the contact hole on the contact hole or larger (B). At this time, the base metal 4 is left so that it is covered entirely by the silicon wafer. It functions to give multiple electrode parts the same electric potential. Next, the parts exclusive of the contact hole part in base metal 4, 5, [6] are coated using a resist 6 (C) and soldering 7 (D) is formed using the electroplating method on exposed base metal 5. After resist 6 has been removed, the solder is heated until it melts and a semi-spherical soldering electrode 7' is formed (E). Last of all, base metal 4 is used to mask soldered sphere 7' and is removed by etching (F). In the above-mentioned method, the formation of the solder is also carried out by using the vapor deposition method.

Nevertheless, when the thickness of the soldered film is 20 or 30 microns in the above-mentioned method, there are a number of drawbacks even when the electroplating method and the vapor deposition method are used: (1) there are many costly individual operations involved; (2) controlling the thickness of the film is difficult; (3) when electroplating is used, etching removal operations for the first layer of the base metal are required; and (4) electrochemical problems arise with soldering elution.

It is an object of the present invention to provide a method for simple formation of a soldered protruding electrode which eliminates the above-mentioned defects.

We shall next use examples to describe the present invention.

Figure 2 A to 2 C illustrates an outline of the operations involved in manufacturing the soldered protruding electrode based on the method in the present invention (the symbols in figure 2 are identical to those in figure 1 and are to be labelled identically). The element function is built in, a surface protective film 3 which is not wetted in the solder and silicon nitride film is formed on the main surface of the silicon wafer which is equipped with (a) silicon substrate 1 which covers the surface protective film (not shown) and (b) aluminum wiring 2 and an opening on the contact hole is made on the electrode formation part (A). Next, base metals 4, 5, 6 are formed on the contact hole using the same method as that indicated in figure 1. These three layers of base metal are etched so that they are left in a circular shape which is larger than the diameter of the contact hole (B). In this case, the first layer of base metal 4 uses (1) an aluminum which is a wiring material and (2)

chromium and titanium which have a great adhesive strength relative to the surface protective film (not shown). The uppermost layer of metal film 8 is easily wetted in the solder and uses nickel and others which can prevent dispersion of tin (which is a component of solder 7) toward intermediate metal layer 5.

The electrical contact between the first layer of base metal 4 and the uppermost layer of base metal 8 on intermediate metal layer 5 is satisfactory and copper and others may be used to upgrade the contact strength of these. Next, we applied flux to the above-mentioned silicon wafer, dipped the entire silicon wafer in the melted solder and lifted it up after 2 to 3 seconds. A semi-spherical solder electrode 7' was formed on the uppermost layer 8 of the base metal as indicated in Figure 2 C. When this method was used, when the diameter of the base metal was 160 micro m, the height of soldering protruding electrode was approximately 40 micro m and the dispersion in height was under +/- 3 micro m.

When the present invention is used, not only are semi-spherical soldered electrodes formed at any height or with slight dispersion in height merely by determining the diameter of the base metal, but this soldered protruding electrode formation can be completed merely by dipping the wafer in a vat with melted solder without going through troublesome operations such as plating and vapor deposition. As a result, the number of required operations is greatly reduced and the time required for forming the protruding electrode is reduced to several seconds. Therefore, the method is greatly effective in that it is extremely easy to use and the operational effectiveness is significantly increased.

Not only does the present invention provide a semi-spherical protruding electrode but it may be used as well to provide a base metal with any shape or dimensions and it can be applied to obtain a protruding electrode of any shape.

4. Brief Description of Figures

Figure 1 is a diagram which illustrates the conventional method for forming a soldered protruding electrode. Figure 2 is a diagram which illustrates the operations using the present invention.

1.....represents the silicon substrate

2.....represents the aluminum wiring

3.....represents the silicon nitride film

4, 5, 8.....represent the base metal

7.....represents the solder

7'.....represents the semi-spherical soldered electrode

Patent Attorney Iwao Yamaguchi